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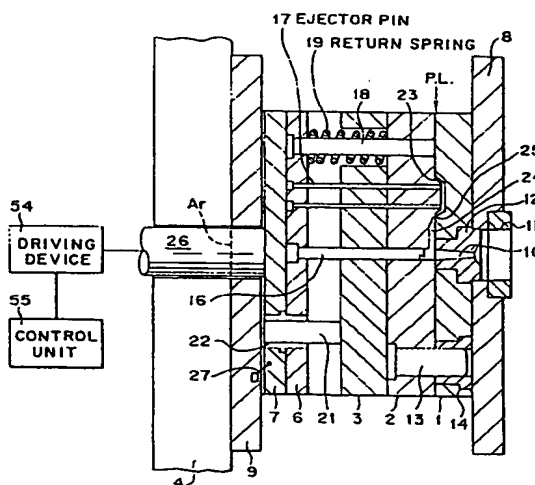
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(54) Injection molding machine, and method for controlling ejection therein.

(57) In an injection molding machine, an ejection is conducted according to at least one of a speed control and a pressure control, until a load is reduced from the start of the ejection. After the load has been reduced, the ejection attended by a very small vibration is conducted. When the ejection is conducted according to the speed control, the deformation of a molded product as a result of the ejection by the ejector pin is reduced, leading to a reduced deformation restoring force. Thus, it is possible to prevent the molded product from being scattered and/or to prevent cracks from being produced in the molded product. In addition, it is possible to release the sticking of the molded product due to the biting of the ejector pin into the molded product, thereby eliminating a time loss and providing an improved efficiency of operation. Each of the speed control and the pressure control is conducted in correspondence to a load. After the ejection attended by the very small vibration has been performed, the ejector pin can be further advanced to effect the ejection. A resisting force can be generated, when the ejector pin is retreated.

FIG.2



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## BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

The present invention relates to an injection molding machine, and a method for controlling the ejection therein.

### DESCRIPTION OF THE PRIOR ART

In general, a prior art injection molding machine is designed, so that a resin heated and melted in a heating cylinder is injected from an injection nozzle in an injecting device, charged into a cavity defined between dies, cooled and solidified, and then, the dies are opened to remove a molded product. In the prior art injection molding machine, the opening of the dies is conducted upon completion of the cooling step, thereby permitting the molded product to be ejected down from the die by an ejector device.

To this end, an ejector pin is disposed with its tip end facing the cavity and with its trailing or rear end fixed on an ejector plate, and an ejecting cylinder is connected to a rear end of the ejector plate through an ejector rod. Thus, when the ejecting cylinder is operated to advance the ejector plate, the ejector pin allows the molded product to be ejected down.

In the ejector device of the prior art injection molding machine, however, the control of the speed of the ejector pin is conducted, so that the ejector pin in the ejector device is changed in ejection speed during the ejection step and advanced at a high speed, a medium speed or a low speed. Therefore, the molded product cannot be ejected down in a short time.

Fig.1 is a diagram illustrating the ejection state of a molded product in the prior art ejector device.

In Fig.1, reference numeral 131 is a molded product; reference numeral 132 is a movable die; and reference numeral 133 is an ejector pin. When the molded product 131 is ejected down by the ejector pin 133, the molded product 131 is deformed into an arched shape, as shown by a solid line in Fig.1, when it is started to be separated from the movable die. After the molded product 131 is restored from such deformation, it may be deformed in an opposite direction, as shown in a dashed line. Thus, the molded product may be scattered by a deformation restoring force, and/or cracks or the like may be produced in the molded product 131.

Thereupon, the control of the speed of the ejector pin 133 may be conducted, so that the ejection speed of the ejector pin 133 is changed in the middle of ejection, whereby the ejector pin 133 is advanced at a low speed (rightwardly as viewed

in Fig.1), in order to prevent the deformation and scattering of the molded product 131. However, it is difficult to establish an optimal ejecting position for changing the ejection speed of the ejector pin 133 at an ejection stroke, resulting in a cycle loss at the ejection step, in a prolonged time required to complete the ejection step, and in an increased cost of operation.

Further, the molded product 131 may be scattered, and/or cracks may be produced in the molded product 131, because the ejector pin 133 is advanced and retreated rapidly.

Yet further, the molded product 131 may be damaged and/or cannot be reliably ejected down, because the ejector pin 133 bites into the molded product.

For the purpose of allowing the molded product to be ejected down from the movable die 132, the ejector pin 133 is advanced and then retreated to the middle of the ejection stroke or the original point of the ejection stroke (i.e., moved leftwardly as viewed in Fig.1), and such advancing and retreating movements are repeated.

In order to repeat the advancing and retreating movements of the ejector pin 133, however, it is necessary to set the ejection speed and the ejection pressure of the ejector pin 133 for each of the advancing and retreating movements, resulting not only in a troublesome operation, but also in a time loss with the operation of the ejecting cylinder, because the time for retreating movement of the ejector pin 133 is set at 0.1 second or more even at minimum. Therefore, a longer time is required until the molded product 131 is ejected down.

Thereupon, an ejector device in an injection molding machine has been proposed, in which the idle-travelling of an ejector rod (which is not shown) until it is put into abutment against an ejector plate (which is not shown), is eliminated.

In this prior art ejector device, however, when the ejector pin 133 has been retreated, the ejector plate is permitted to collide against a movable mounting plate (which is not shown), and upon such collision, a shock sound exceeding 90 dB may be generated.

### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for controlling the ejection in an injection molding machine, wherein the problems associated with the ejector device in the prior art injection molding machine are overcome, thereby preventing the scattering of a molded product, a cracking in the molded product and a damaging of the molded product due to the biting of the ejector pin into the molded product, and it is possible to eject down the molded product reliably within a

short time, to provide a simplified operation and to reduce the shock sound generated upon collision of the ejector plate against the movable mounting plate, when the ejector pin is retreated.

To achieve the above object, according to the present invention, there is provided an injection molding machine, comprising a stationary die, a movable die disposed in an opposed relation for movement into and out of contact with the stationary die to define a cavity between both the dies, an ejector pin disposed with its tip end facing the cavity, a driving device for advancing the ejector pin, and a control unit for controlling the driving device, the control unit performs (i) an ejection according to at least one of a speed control and a pressure control, until a load is reduced from the start of the ejection, and (ii) an ejection attended by a very small vibration, after the load has been reduced.

In addition, according to the present invention, there is provided a method for controlling the ejection in an injection molding machine, comprising the steps of conducting an ejection according to at least one of a speed control and a pressure control, until a load is reduced from the start of the ejection, and conducting an ejection attended by a very small vibration, after the load has been reduced.

With the above features of the present invention, when the ejection is conducted according to the speed control, the deformation of a molded product with the ejection thereof by the ejector pin is reduced, leading to a reduced deformation restoring force. Therefore, it is possible to prevent the molded product from being scattered, and/or to prevent cracks from being produced in the molded product. In addition, it is possible to release the sticking of the molded product due to the biting of the ejector pin into the molded product within a short time, thereby eliminating the time loss and providing an improved efficiency of operation.

In this case, the speed control and the pressure control may be conducted in correspondence to the load. Therefore, it is possible to immediately change-over the pressure control to the speed control to provide an improved efficiency of operation.

After the ejection attended by the very small vibration has been conducted, the ejector pin can be also further advanced to effect the ejection. Therefore, even when the molded product cannot be reliably ejected down with only the very small vibration, the molded product can be reliably ejected down.

A resisting force can be generated, when the ejector pin is retreated. Thus, the speed at which the ejector plate is retreated is lowered, leading to a reduced shock sound generated upon the collision of the ejector plate against the movable mounting plate.

Further, the change-over of each ejection can be conducted in accordance with a change-over time previously set or a change-over position previously established.

The above and other objects, features and advantages of the invention will become apparent from a consideration of the following description of the preferred embodiment taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a diagram illustrating the ejection state of a molded product in the prior art ejector device.

Fig.2 is a sectional view of an injection molding machine according to a first embodiment of the present invention;

Fig.3 is a graph illustrating the relationship between the ejecting position and the required ejection pressure in the first embodiment;

Fig.4 is a graph illustrating the relationship between the ejecting position and the time in the first embodiment;

Fig.5 is a time chart with respect to the ejection speed and the ejection pressure of the ejector pin in the first embodiment;

Fig.6 is a sectional view of an injection molding machine according to a second embodiment of the present invention; and

Fig.7 is a graph illustrating the relationship between the ejecting position and the time in the second embodiment.

#### DESCRIPTION OF PREFERRED EMBODIMENT

The present invention will now be described by way of preferred embodiments in connection with the accompanying drawings.

Referring to Fig.2, an injection molding machine according to a first embodiment of the present invention is shown in sectional view. This injection molding machine comprises a stationary die 1, a movable die 2 disposed in an opposed relation to the stationary die 1 for movement into and out of contact with the stationary die 1, so as to define a cavity 23 between both the dies, when in contact with the stationary die 1, the movable die 2 being reinforced by a receiving plate 3, a movable platen 4, an upper ejector plate 6, a lower ejector plate 7, a stationary mounting plate 8 for mounting the stationary die 1 to a stationary plate (which is not shown), and a movable mounting plate 9 for mounting the movable die 2 to the movable platen 4.

The injection molding machine further includes a sprue 10, a locating ring 11 for facilitating the mounting of the stationary die 1 to the stationary

platen and for permitting a smooth nozzle touching, a sprue bush 12 for guiding a resin injected from an injecting nozzle which is not shown, a guide pin 13 mounted to the movable die 2 for guiding the stationary die 1, a guide bush 14, a sprue lock pin 16 disposed with its tip end facing the sprue 10 to extend through the movable die 2, an ejector pin 17 disposed with its tip end facing the cavity 23 to extend through the movable die 2, a return pin 18, and a return spring 19 disposed to enclose the return pin 18 for biasing the upper ejector plate 6 rearwardly.

Each of the sprue lock pin 16, the ejector pin 17 and the return pin 18 has, at its rear or trailing end, a flange portion which is clamped by the upper and lower ejector plates 6 and 7.

Further, the injection molding machine includes an ejector guide pin 21 functioning to permit a smooth ejection by the ejector pin 17, an ejector guide pin bush 22, a runner 24, and a gate 25. Reference character P.L. in Fig.2 designates a parting line between the stationary and movable dies 1 and 2.

In the injection molding machine having the above-described construction, when the resin is injected in a condition in which the injecting nozzle is in abutment against the sprue bush 12, it is passed through the sprue 10, the runner 24 and the gate 25 into the cavity 23.

Upon the completion of an injection step, a pressure maintaining step is conducted for replenishing the resin into the cavity 23 with shrinkage of the resin within the cavity 23. Then, the resin is cooled to provide a molded product which is not shown. Thereupon, the movable die 2 is retreated leftwardly as viewed in Fig.2 away from the stationary die 1, thus effecting the opening of the dies.

At this time, the ejector pin 17 is advanced rightwardly as viewed in Fig. 2, thereby causing the molded product to be ejected down from the movable die 2. For this purpose, an ejector rod 26 is disposed at a rear end of the lower ejector plate 7 and driven by a driving device 54 for advancing and retreating movement into and out of contact therewith.

The driving device 54 comprises, for example, an ejector cylinder. Reference numeral 55 is a control unit for controlling the driving device 54, and reference character Ar is a retreat limit position for the ejector rod 26.

A retreat-certifying switch 27 is disposed between the lower ejector plate 7 and the movable mounting plate 9 to detect the completion of the retreating movement of the ejector plates 6 and 7. Usually, the injection molding machine is operated in an automatic mode, a semi-automatic mode or a manual mode. When the operational mode of the machine has been switched-over from the auto-

matic mode or the semi-automatic mode to the manual mode, or when the ejector pin 17 has been retreated to its ejection starting position, the retreat-certifying switch 27 is turned OFF.

In the first embodiment, the relationship between the ejecting position and the ejecting pressure is established as shown in Fig.3.

In Fig.3, Ar indicates the retreat limit position for the ejector rod 26; B indicates an ejection starting position occupied by the ejector pin 17 when the ejector plates 6 and 7 have been retreated by the action of the return spring 19; C indicates a release position in which a molded product (not shown) is released from the movable die 2; and D indicates an advance limit position, i.e., a maximum ejection position for the ejector pin 17, which is a dropping position for the molded product.

In the first embodiment, the relationship between the ejecting position and the time is established as shown in Fig.4.

In Fig.4, Ar indicates the retreat limit position for the ejector rod 26 (see Fig.2); B indicates the ejection starting position for the ejector pin 17; C indicates the release position for the molded product (not shown); and D indicates the dropping position for the molded product.

In addition, in Fig.4, a indicates an operation starting point, wherein the ejector rod 26 is in its retreat limit position Ar; b indicates an ejection starting point, wherein the ejector pin 17 is in its ejection starting position B; c indicates a release point at which the release of the molded product from the movable die 2 is started, wherein a sticking between the molded product and the movable die 2 is loosened by advancement of the ejector pin 17, thereby providing a released state. At this time, the ejector pin 17 is in the release position C. Then, the ejector pin 17 is pushed at a low speed from the ejection starting position B to the release position C. This prevents the molded product from being scattered by a deformation restoring force, or prevents cracks from being produced in the molded product.

Alternatively, the releasing of the molded product may be started when the ejector pin 17 has reached the release position C, or the releasing of the molded product may be started when the release point c has been detected by a timer which is not shown.

In this embodiment, the control of the ejecting pressure is carried out in correspondence to a load, until the release point c is reached, while the load corresponding to the ejecting pressure is detected by a hydraulic pressure, an electric current or torque, and when the load has been reduced, the release point c is detected.

When the reaching of the release point c has been detected, the control of the ejection pressure is immediately switched over to a control of speed, so that the ejector pin 17 is advanced at a high speed.

Further, in Fig.4, d indicates a very small vibration starting point at which a very small vibration is started; and e indicates a very small vibration completion point at which the very small vibration is completed. Between the very small vibration starting point and the very small vibration completion point, the ejector pin 17 is in the dropping position D in which the molded product is reliably dropped. At the vibration starting point d, the very small vibration is started by instantaneously retreating the ejector pin 17 either by operating an ejector device or by a spring force of the return spring 19, and the repeating of the advancing and retreating movements of the ejector pin 17 causes a very small vibration. At this time, the ejector pin 17 biting into the molded product is retreated, while the molded product is intended to be further advanced by an inertia force generated until the molded product has reached the dropping position D, and thus, the molded product is completely released and dropped from the die.

Therefore, there is no time loss in the ejection step, but also an improved efficiency of operation is provided.

In the very small vibration, it is necessary to advance and retreat the ejector pin 17 at a required speed within a very short time, but each of the time and speed for advancing and retreating movements of the ejector pin 17 may be a value enough to permit the release of the bite-in sticking of the ejector pin 17 to the molded product. They substantially need not be changed after being once set, and in a special case, they may be set within a board which is not shown. Usually, an operator sets only the number of repeats of the advancing and retreating movements of the ejector pin 17 on a setting panel surface which is not shown.

When the very small vibration is repeated by a preset number of times (a single very small vibration is performed in a predetermined time such as 0.05 seconds or less, preferably in a range of 0.01 to 0.02 seconds), the ejector pin 17 is retreated from the dropping position D to the ejection starting position B. It is noted herein that f indicates an ejection completion point.

At this time, the ejector pin 17 is retreated from the dropping position D to the ejection starting position B by only the spring force of the return spring 19. Therefore, at the ejection completion point f, a lowered shock sound may be generated by collision of the lower ejector plate 7 against the movable mounting plate 9.

In the present embodiment, the controls of the ejection pressure and the speed are carried out according to a computer program of the control unit 55, but the ejector rod 26 may be operated manually, and in this case, the ejector rod 26 can be retreated to the retreat limit position Ar. This ensures that the ejector rod 26 and the movable mounting plate 9 can be prevented from being damaged due to the interference with each other, when the movable die 2 is mounted to the movable mounting plate 9.

A method for controlling the ejection in the injection molding machine according to the present invention will be described below.

First, in starting the operation of the ejector device, a time  $T_1$  is set by a timer which is not shown, and a preset value  $P_0$  of ejection pressure is set, as shown in Fig.5. During the time  $T_1$ , the ejector pin 17 (Fig.2) is pushed according to the control of the ejection pressure. Therefore, the molded product (which is not shown) can be prevented from being scattered, and cracks can be prevented from being produced in the molded product.

When the ejector pin 17 has reached the release position C (see Fig. 4), the molded product is released from the movable die 2. Thereafter, when the sticking force between the molded product and the movable die is eliminated, the load is reduced, so that the ejection speed  $V_1$  of the ejector pin 17 is rapidly increased. For this reason, an upper limit ejection speed  $V_2$  may be previously set.

Then, during a time  $T_2$ , the ejector pin 17 is pushed at the upper limit speed  $V_2$  according to the speed control until it reaches the dropping position D. During this time, the load is reduced.

Subsequently, the very small vibration is started at the dropping position D, so that the advancing and retreating movements of the ejector pin 17 are repeated. It is necessary to advance and retreat the ejector pin 17 at the required speed within the very short time, but each of advancing times  $T_4$  and  $T_5$  and retreating times  $T_3$  and  $T_5$  and advancing and retreating speeds need not be changed, but may be changed within the board (which is not shown) only in a special case.

In the very small vibration in the present embodiment, each of the advancing times  $T_4$  and  $T_5$  was of 0.01 second; each of the retreating times  $T_3$  and  $T_5$  was of 0.02 seconds; each of the advancing and retreating speeds is medium or high; and the number of repeats was two. By setting the times and speeds in this manner, the molded product could be ejected down substantially completely.

When the very small vibration has been completed, the ejector plates 6 and 7 are retreated by the action of the return spring 19, which is attended by the retreating movement of the ejector pin 17.

Upon the completion of the retreating movement of the ejector plates 6 and 7, the retreat-certifying switch 27 is operated. On the other hand, the countdown of a time  $T_7$  is started at a time point at which the time  $T_2$  has been lapsed, and upon the operation of the retreat-certifying switch 27 and upon the counting-up of the time  $T_7$  by the timer, the subsequent die-clamping is started.

In the present embodiment, the timer is used to change-over the individual operations from one to another, and change-over times are set in the timer, but alternatively, a position detector may be used in place of the timer, and change-over positions may be established.

A second embodiment of the present invention will now be described in connection with Figs.6 and 7.

Referring to Fig.6, an injection molding machine of the second embodiment comprises a stationary die 1, a movable die 2 disposed in an opposed relation to the stationary die 1 for movement into and out of contact with the stationary die 1, so as to define a cavity 23 between both the dies, when in contact with the stationary die 1, the movable die 2 being reinforced by a receiving plate 3, a movable platen 4, an upper ejector plate 6, a lower ejector plate 7, a stationary mounting plate 8 for mounting the stationary die 1 to a stationary plate (which is not shown), and a movable mounting plate 9 for mounting the movable die 2 to the movable platen 4.

Further, the injection molding machine includes a sprue 10, a locating ring 11 for facilitating the mounting of the stationary die 1 to the stationary platen and for permitting a smooth nozzle touching, a sprue bush 12 for guiding a resin injected from an injecting nozzle which is not shown, a guide pin 13 mounted to the movable die 2 for guiding the stationary die 1, a guide bush 14, a sprue lock pin 16 disposed with its tip end facing the sprue 10 to extend through the movable die 2, an ejector pin 17 disposed with its tip end facing the cavity 23 to extend through the movable die 2, a return pin 18, and a return spring 19 disposed to enclose the return pin 18 for biasing the upper ejector plate 6 rearwardly.

Each of the sprue lock pin 16, the ejector pin 17 and the return pin 18 has a flange portion at its rear or training end, which flange portion is clamped by the upper and lower ejector plates 6 and 7.

The injection molding machine further includes an ejector guide pin 21 functioning to permit a smooth ejection by the ejector pin 17, an ejector guide pin bush 22, a runner 24, and a gate 25. Reference character P.L. in Fig.2 designates a parting line between the stationary and movable dies 1 and 2.

In the injection molding machine having the above-described construction, when the resin is injected in a condition in which the injecting nozzle is in abutment against the sprue bush 12, it is passed through the sprue 10, the runner 24 and the gate 25 into the cavity 23.

Upon the completion of an injection step, a pressure maintaining step is conducted for replenishing the resin into the cavity 23 with shrinkage of the resin within the cavity 23. Then, the resin is cooled to provide a molded product which is not shown. Thereupon, the movable die 2 is retreated leftwardly as viewed in Fig.2 away from the stationary die 1, thus effecting the opening of the dies.

At this time, the ejector pin 17 is advanced rightwardly as viewed in Fig.2, thereby causing the molded product to be ejected down from the movable die 2. For this purpose, an ejector rod 26 is disposed at a rear end of the lower ejector plate 7 and driven for advancing and retreating movement into and out of contact therewith by an ejecting cylinder 30 functioning as a driving device. Reference character Ar is a retreat limit position for the ejector rod 26.

A piston 31 is slidably disposed in the ejecting cylinder 30 to define a first oil chamber 32 and a second oil chamber 33. The first and second oil chambers 32 and 33 are connected to a hydraulic valve 38 through oil passages 35 and 36, respectively. Reference numeral 39 designates an oil pump for supplying an oil into the first and second oil chambers 32 and 33, and reference numeral 40 denotes an oil tank.

The hydraulic valve 38 is operated by solenoids a and b, so that it assumes a position A, when the solenoid a is turned ON, thereby permitting an oil discharged by the oil pump 39 to be supplied through the oil passage 35 into the first oil chamber 32, while permitting the oil in the second oil chamber 33 to be drained through the oil passage 36 into the oil tank 40. At this time, the ejector rod 26 is retreated.

Further, the hydraulic valve 38 assumes a position N, when the solenoids a and b are turned OFF, thereby permitting the oil in the first and second oil chambers 32 and 33 to be drained through the oil passages 35 and 36 into the oil tank 40. The hydraulic valve 38 includes constrictions 41 and 42, through which the oil is drained into the oil tank 40.

The solenoids a and b are connected to and turned ON and OFF by a control unit 55. Reference numeral 50 is a variable constriction, and reference numeral 51 is a check valve.

The operation of the injection molding machine having the above-described construction will be described below in connection with a combination of Figs.6 and 7.

Usually, the injection molding machine is operated in an automatic mode, a semi-automatic mode or a manual mode, but when the automatic mode or the semi-automatic mode is selected, the ejector rod 26 is advanced at a preset speed for a preset time from the retreat limit position Ar before a first ejection is conducted.

Thereafter, the solenoids a and b of the hydraulic valve 38 are turned OFF. At this time, the ejector rod 26 is retreated by the spring force of the return spring 19, and the oil in the first and second oil chambers 32 and 33 in the ejecting cylinder 30 is drained through the oil passages 35 and 36 and the constrictions 41 and 42 respectively into the oil tank 40.

In this case, the oil flows through the constrictions 41 and 42, so that a resisting force opposing the spring force of the return spring 19 is generated. Therefore, the speed at which the lower ejector plate 7 is retreated is lowered and hence, the shock generated upon the collision of the lower ejector plate 7 against the movable mounting plate 9 is reduced, and the shock sound is also reduced on the order of 10 dB.

In addition, at this time, with the completion of the retreating movement of the lower ejector plate 7 upon the collision thereof against the movable mounting plate 9, the ejector rod 26 is stopped at the ejection starting position B and hence, the first ejection is conducted from the ejection starting position B. Therefore, in conducting the ejection again, the ejector rod 26 cannot be idle-travelled from the retreat limit position Ar to the ejection starting position B.

Then, the movable platen 4 is advanced to provide a die-clamping, and the resin is injected and charged into the cavity 23, and then cooled, following which the die-opening is conducted.

Then, the ejector rod 26 is advanced at a low speed provided according to the speed control for a preset time or until it reaches a previously established position E (or until an electric motor is driven by a preset pulse number, when the electric motor is used in place of the ejecting cylinder 30). In this case, when a material of the molded product is a hard resin, only the speed control is carried out, or when the material is a soft resin such as an elastomer, the ejector rod 26 is advanced with a low pressure provided by the control of the ejection pressure. Therefore, the ejector pin cannot excessively bite into the molded product.

Then, the very small vibration is started. More specifically, the ejector pin 17 is advanced at a medium or high speed for a very short time less than 0.1 second and retreated for a very short time less than 0.1 second, and the advancing and retreating movements are repeated. In the very small vibration of the ejector pin 17 in the present em-

bodiment, the ejector pin 17 is advanced for 0.03 seconds and then retreated for 0.03 seconds, and the advancing and retreating movements are repeated 9 times at maximum. It should be noted that the advancing movement of the ejector pin 17 is caused by a hydraulic pressure in the ejecting cylinder 30, and the retreating movement of the ejector pin is caused by the spring force of the return spring 19. Therefore, there is no time loss with the operation of the ejecting cylinder 30, thereby enabling a shortened cycle time until the molded product is ejected down. At this time, the ejector pin 17 biting into the molded product is retreated, while the molded product is intended to be further advanced by an inertia force and hence, is completely released and dropped from the die.

In the very small vibration, it is necessary to repeat the advancing and retreating movements within a very short time, but each of the time and speed for advancing and retreating movements of the ejector pin 17 may be a value enough to permit the release of the bite-in sticking of the ejector pin 17 to the molded product.

It should be noted that the magnitude of the amplitude of the very small vibration can be changed depending upon the shape, the quality and the like of the molded product.

When the molded product is shallow, it can be reliably ejected down at this stage, and the ejector rod can be immediately retreated, leading to a correspondingly shortened cycle time until the molded product is ejected down. In addition, until the very small vibration is started, the ejector rod 26 is advanced at a low speed, leading to a reduced shock to the molded product and ensuring that the molded product is prevented from being scattered, and/or cracks are prevented from being produced in the molded product.

When the solenoids a and b of the hydraulic valve 38 are then turned OFF, the ejector rod 26 is retreated by the spring force of the return spring 19, and the oil in the first and second oil chambers 32 and 33 in the ejecting cylinder 30 is drained through the oil passages 35 and 36 and the constrictions 41 and 42 respectively into the oil tank 40.

In this case, the oil flows through the constrictions 41 and 42 and hence, the speed at which the lower ejector plate 7 is retreated is lowered and hence, the shock generated upon the collision of the lower ejector plate 7 against the movable mounting plate 9 is reduced, and the shock sound is also reduced on the order of 15 dB. Then, the operation is passed to a next cycle.

When the molded product is deep, it cannot be reliably ejected down only with the very small vibration. Thereupon, the ejector rod 26 is advanced to a position F enough to permit the mol-

ded product to be ejected down. In this case, the tip end of the ejector pin 17 is in a location sufficiently spaced apart from the movable die 2 and hence, the molded product is reliably ejected down.

If air is supplied in a jet manner from the above of the molded product, the molded product which is about to be released from the movable die 2 and the runner 24 are completely released and ejected down from the movable die 2. In addition, it is possible to prevent the molded product from being scattered.

Thereafter, if the solenoids a and b of the hydraulic valve 8 are turned OFF, the ejector rod 26 is retreated by the spring force of the return spring 19, and the oil in the first and second oil chambers 32 and 33 in the ejecting cylinder 30 is drained through the oil passages 35 and 36 and via the constrictions 41 and 42 respectively into the oil tank 40. This is followed by a next cycle.

In this case, the oil flows through the constrictions 41 and 42 and hence, a resisting force opposing the spring force of the return spring 19 is generated.

When it is difficult to eject the molded product down by the ejector pin 17, a variable constriction 50 and a check valve may be disposed in parallel to each other, so that the resisting force generated during retreating movement of the ejector rod 26 can be varied by adjusting the variable constriction 50.

If a mode switch which is not shown is turned OFF or the manual mode is selected when the ejection in the automatic mode or the semi-automatic mode has been completed, the ejector rod 26 can be retreated to the retreat limit position Ar for any time and at any speed. This causes the tip end of the ejector rod 26 to be located at an inner position than the end face of the movable platen 4 and hence, both of them cannot be damaged in attaching and detaching the movable die 2 to and from the movable platen 4.

Both or either one of the constrictions 41 and 42 and the variable constriction 50 may be provided. Alternatively, another resisting-force generating means may be provided.

In the present embodiment, the ejecting cylinder 30 is used as the driving device for advancing and retreating the ejector rod 26, but when the electric motor is used in place of the ejecting cylinder 30, the number of revolutions may be controlled in place of the speed, and the number of pulses may be controlled in place of the position. In this case, the resisting force opposing the spring force of the return spring can be controlled by an electric current supplied to the motor, and the speed of the ejector rod 26 can be controlled by the number of pulses.

Although the embodiments of the present invention have been described, it will be understood that the present invention is not limited thereto, and various modifications and variations can be made without departing from the spirit and scope of the invention defined in claims.

## Claims

1. An injection molding machine, comprising
  - a stationary die,
  - a movable die disposed in an opposed relation for movement into and out of contact with said stationary die to define a cavity between both the dies,
  - an ejector pin disposed with its tip end facing said cavity, a driving device for advancing said ejector pin, and
  - a control unit for controlling said driving device,
 said control unit performs
  - (i) an ejection according to at least one of a speed control and a pressure control, until a load is reduced from the start of the ejection, and
  - (ii) an ejection attended by a very small vibration, after the load has been reduced.
2. A method for controlling the ejection in an injection molding machine, comprising the steps of
  - conducting an ejection according to at least one of a speed control and a pressure control, until a load is reduced from the start of the ejection, and
  - conducting an ejection attended by a very small vibration, after the load has been reduced.
3. A method for controlling the ejection according to claim 2, wherein each of said speed control and said pressure control is conducted in correspondence to a load.
4. A method for controlling the ejection according to claim 2, wherein after the ejection attended by the very small vibration has been performed, the ejector pin is further advanced to effect the ejection.
5. A method for controlling the ejection according to claim 2, wherein a resisting force is generated when the ejector pin is retreated.
6. A method for controlling the ejection according to claim 2, wherein the change-over of each ejection is conducted in accordance with a change-over time previously set.



7. A method for controlling the ejection according to claim 2, wherein the change-over of each ejection is conducted in accordance with a change-over position previously established.

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FIG. 1  
(PRIOR ART)

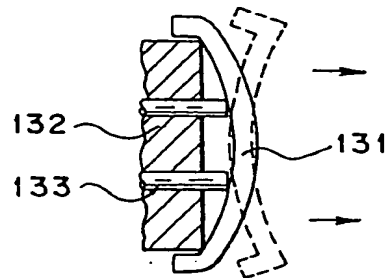


FIG. 2

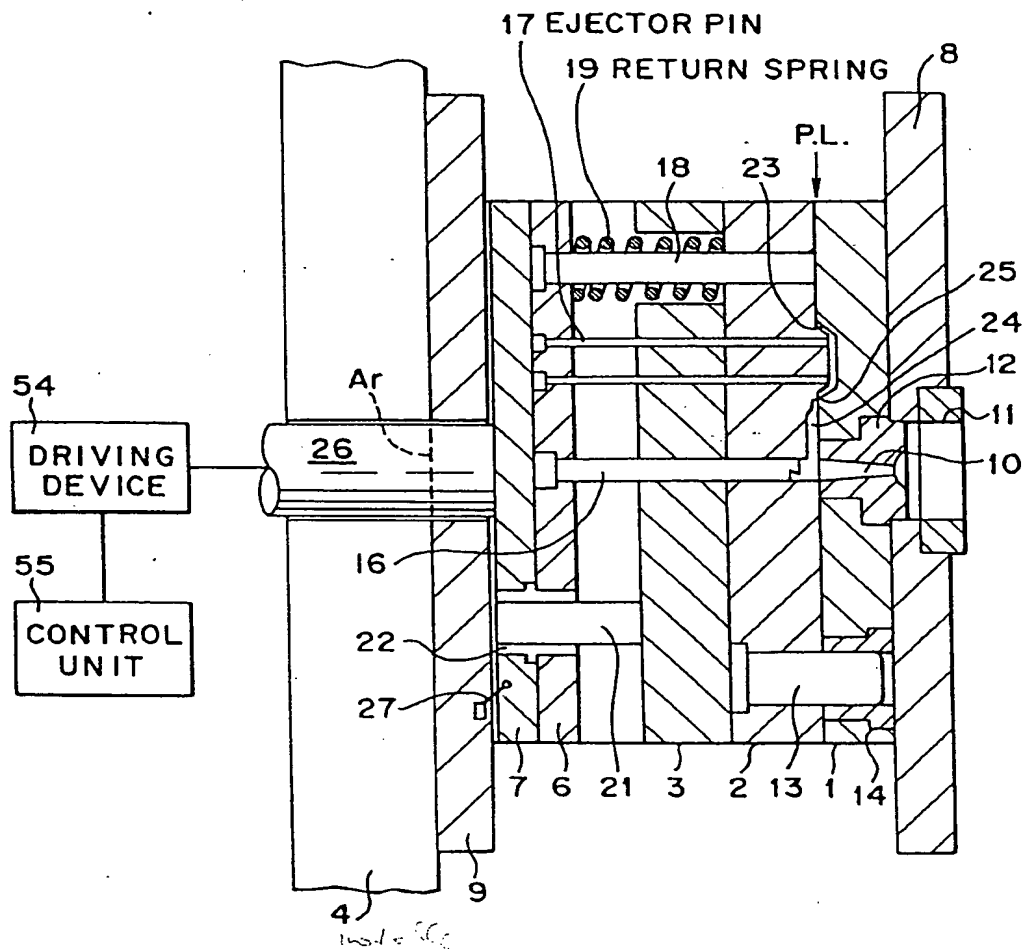


FIG.3

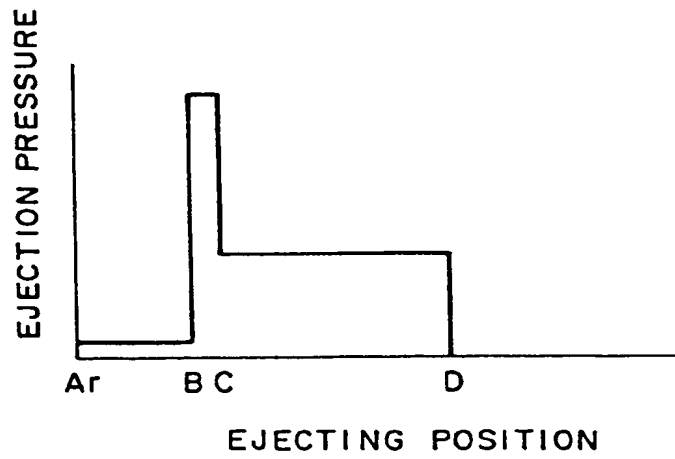


FIG.4

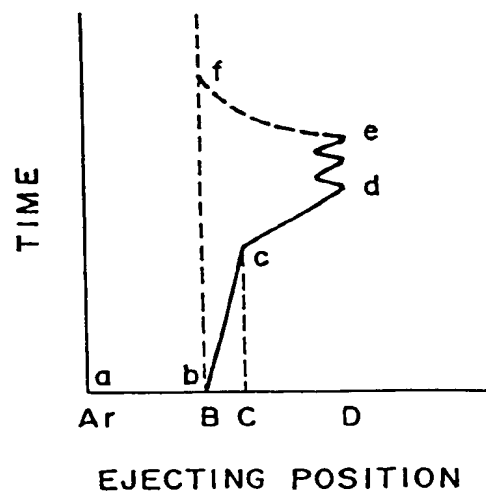


FIG. 5

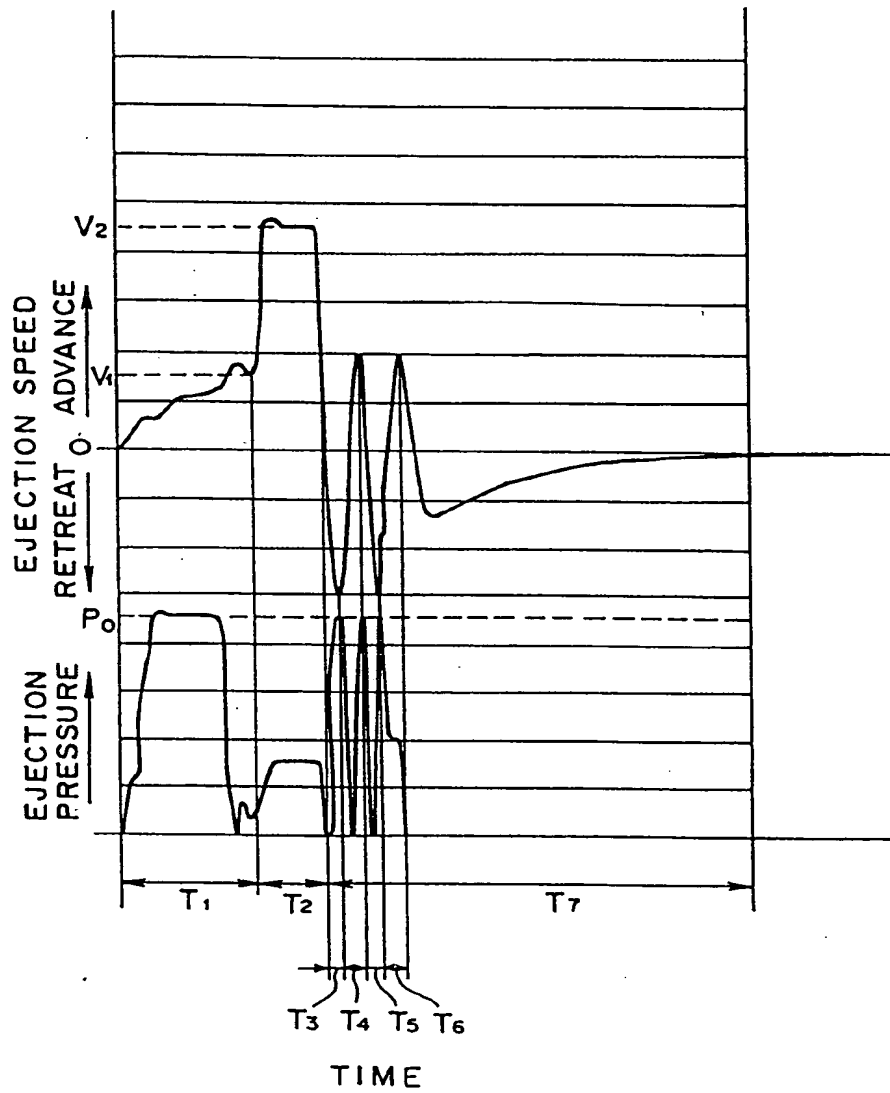


FIG. 6

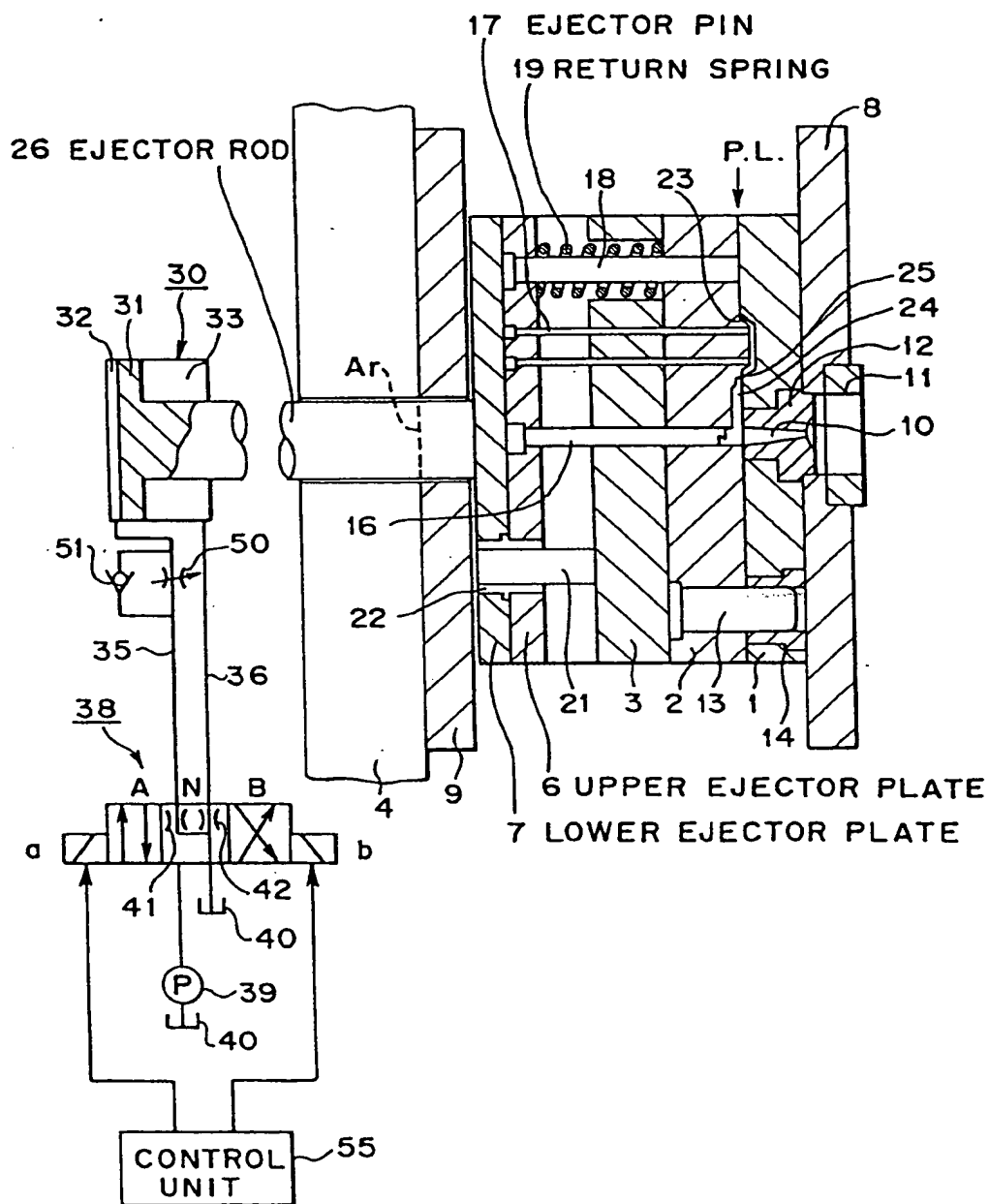
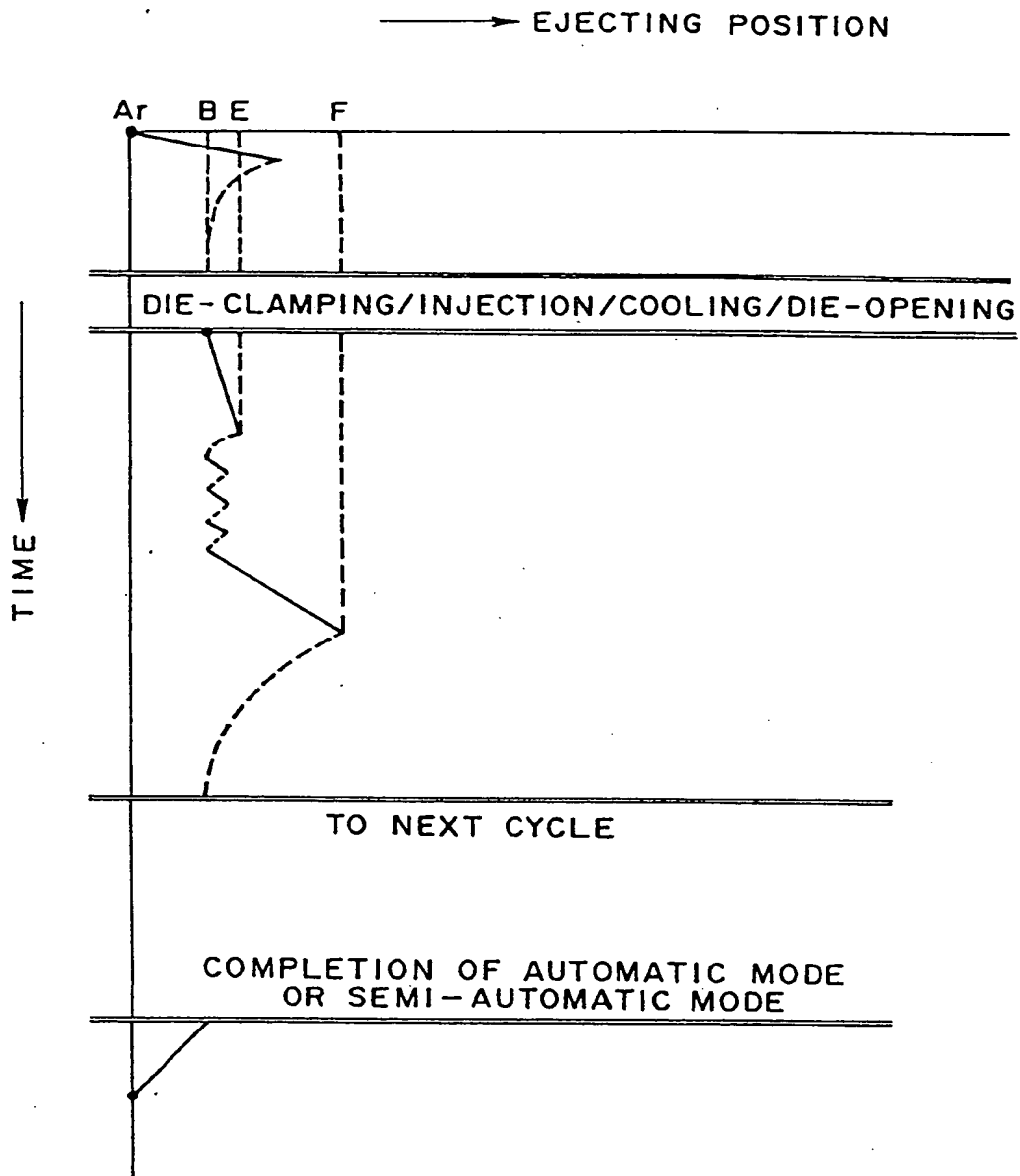


FIG.7





European Patent  
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## EUROPEAN SEARCH REPORT

Application Number  
EP 93 11 6318

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 12, no. 45 (M-667)(2892) 10 February 1988 & JP-A-62 197 261 (TOYO KIKAI KINZOKU) * abstract *	1,2	B29C45/76 B29C45/40
Y	--- PATENT ABSTRACTS OF JAPAN vol. 14, no. 23 (M-920)(3966) 17 January 1990 & JP-A-01 263 018 (MITSUBISHI HEAVY IND. LTD.) * abstract *	1,2	
Y	--- PATENT ABSTRACTS OF JAPAN vol. 10, no. 118 (M-475)(2175) 2 May 1986 & JP-A-60 247 533 (TOSHIBA KIKAI) * abstract *	1,2	
Y	--- PATENT ABSTRACTS OF JAPAN vol. 11, no. 321 (M-633)(2768) 20 October 1987 & JP-A-62 104 723 (MEIKI CO. LTD.) * abstract *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.5)
Y	--- PATENT ABSTRACTS OF JAPAN vol. 11, no. 196 (M-601)(2643) 24 June 1987 & JP-A-62 019 422 (MATSUSHITA ELECTRIC WORKS) * abstract *	1,2	B29C B22D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 January 1994	Examiner Bollen, J
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document I : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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